# APPENDIX D

## ATMOSPHERIC PRESSURE SETUP

In Chapter 1, it was noted that atmospheric pressure variations over the sea cause the water level to rise in areas of low pressure and fall in areas of high pressure. This appendix is concerned with estimating the amount of rise attributed to the decrease in atmospheric pressure associated with hurricanes. A rise in water due to the pressure effect is commonly referred to as "pressure setup". The response of the water to pressure is like that of an inverted barometer and thus also frequently is referred to as the "inverted barometer effect". An expression for the atmospheric pressure in a hurricane was given in Appendix C (see Equation [C-1]) as

$$p = p_o + (p_n - p_o)\ e^{-R/r} \qquad \text{[D-1]}$$

in which p is the pressure at a radial distance r from the hurricane center; $p_o$ is the central pressure; $p_n$ is the peripheral pressure; and R is the radius of maximum winds. Equation [D-1] may be readily written in terms of the rise in water level at any distance r from the hurricane center, or specifically

$$\xi = 1.14\ (p_n - p_o)\ (1 - e^{-R/r}) \qquad \text{[D-2]}$$

in which $\xi$ is, as before (Chapter 1), an equivalent head of water in feet when the pressures $p_n$ and $p_o$ have units of inches of mercury. A certain lapse of time is required for the water to respond to a change in sea-level pressure, thus pressure setup is a time dependent process which requires that water in higher pressure areas be transported to the lower pressure area. As a consequence, Equation [D-2] is considered more valid for slow moving hurricanes and in regions where the water depth is relatively deep. In shallow coastal areas the equilibrium pressure setup, as predicted by the expression given, would be seldom reached due to the effects of bottom friction. Generally, the pressure setup effect can be neglected in shallow bays and estuaries. The gradient pressure setup which appears in the equations of motion as given in Chapter 1 can be expressed from Equation [C-2] as:

$$\frac{\partial \xi}{\partial x} = 1.14 \, (p_n - p_o) \, \frac{R}{r^2} \, e^{-R/r} \cos \beta \qquad [D-3]$$

$$\frac{\partial \xi}{\partial y} = 1.14 \, (p_n - p_o) \, \frac{R}{r^2} \, e^{-R/r} \sin \beta \qquad [D-4]$$

in which $\beta$ is the angle between the x-axis and the radial line from the storm center to the point in which the pressure setup is to be evaluated.